JAPANESE [JP,10-174428,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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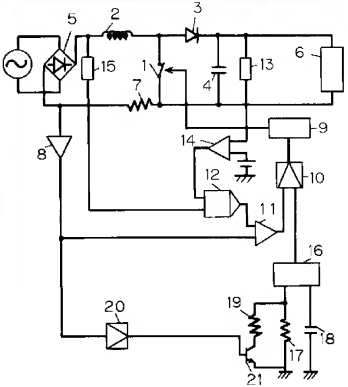
DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]In the power supply circuit changed into a direct current from exchange, this invention relates to the circuit which improves a power-factor.
[0002]
[Description of the Prior Art]This conventional kind of power factor improvement circuit is explained.
[0003]The capacity input type rectification smoothing circuit as shown in drawing 11 is applied to many of electric appliances, in order to attain improve efficiency and a miniaturization.
[0004]Current flows only through near the peak of the pulsating flow voltage after rectification in such a rectification circuit. The period when this current flows is called "on" period.
[0005]This is for the diode bridge 5 of drawing 11 to serve as forward bias, and to flow only near the peak of pulsating flow voltage. An "on" period is dramatically short to one cycle of commercial power frequency, and the current which flows through that becomes sharp pulse form. Pulse form current makes a voltage waveform generate distortion by a part for a resisted part or inductance of wiring.
[0006]This state has a low power-factor, and becomes causes, such as malfunction of the device resulting from generating and it of power supply harmonics, and an abnormal heat generation.
[0007]In order to bring the current wave form distorted in this way

Drawing selection Representative draw



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close to a sine wave, a power factor improvement circuit as shown in drawing 10 is used.

[0008]This by turning on and off the current switching means 1 based on the signal from the detection means 10 of the pulsating flow voltage after rectification, the detection means 13 of the voltage after rectification by the diode 3 and the current sensing resistor 7, and the current detecting means 8, Current is controlled and it serves to aim at power factor improvement by bringing the current which flows through the diode bridge 5 close to a sine wave.

[0009]

[Problem(s) to be Solved by the Invention]However, in the power factor improvement circuit, it had the technical problem that a power-factor changed, namely, a power-factor declined by a load change also in which mold at the time of a light load although the lowered type of the pressure, a step-down-and-step-up type, etc. have some kinds other than a pressure-up type as shown in drawing 10.

[0010]Although the current sensing resistor which makes a part of current detecting means in a power factor improvement circuit was indispensable, reduction of the loss of the electric power by a current sensing resistor was also a technical problem simultaneously.

[0011]In the above power factor improvement circuits, while outputting 100% of electric power to rating, it had the technical problem that it got extremely bad with 0.5-0.7 also in a circuit with the power-factor near about 1 at the time of the light load whose output is 10% of rating.

[0012]Thus, the current which flows through a coil among one cycle to which the current switching means operates as one of the causes by which a power-factor gets worse at the time of a light load may become zero, current control may become insufficient, and it may be said that distortion of a current wave form is not amended as a result.

[0013]usually, with a coil with the general characteristic, to change of load current, although inductance is about 1 law, it can secure a predetermined power-factor (0.98 or more [for example,]) to the rating of a power factor improvement circuit at the time of 100% of load in such the characteristic. However, it is for the section when load current becomes small at, current becomes discontinuous at, for example at the time of 10% of load of rating at the time of a light load, and power-factor-improvement control cannot be performed enough to occur.

[0014]The above-mentioned concrete explanation is given using the formulas 1 and 2. In the period of one of a current switching means

[0015]

[Equation 1]

$$\frac{di}{dt} = \frac{Vdc}{L} \qquad \text{式1}$$

Vdc：全波整流後の電圧の瞬時値

L：コイルのインダクタンス

[0016]The current which came out and had the inclination expressed flows through a coil. The inclination of current is decided

only by the instantaneous value of voltage, and inductance of a coil as the formula 1 showing, and influence is not received in the size of load. the case where one half of the effective values Irms of the current which flows through a coil always exceeds the product of the above-mentioned current inclination and the conduction time Ton of the current switching means 1 -- namely [0017]

[Equation 2]

$$\frac{1}{2}\,Irms \geqq \frac{Vdc}{L}\cdot Ton \qquad \text{式2}$$

[0018]When ******(ing), the current which flows through a coil becomes continuously and will be in the state where the effect of power factor improvement is the highest. This state corresponds, when the power factor improvement circuit is outputting rated load or the load current near it.

[0019]On the contrary, although the formula 2 was not materialized but the current switching means 1 has flowed as a result when the power factor improvement circuit is outputting 50% or less of load current as opposed to rated load, the period when current does not flow occurs.

[0020]Since this state cannot be called current discontinuity and this period cannot control current, the effect of power factor improvement falls. Since the value of the left side of the formula 2 became small so that the load of a power factor improvement circuit becomes light (i.e., so that load current becomes small), the period of current discontinuity became long, the period out of control became long, and it had the technical problem that the effect of power factor improvement fell further as a result.

[0021]above-mentioned current in order to solve the above-mentioned technical problem that the fall of the power-factor-improvement effect is prevented also in the time of low loading -- it is required to lose or shorten a discontinuous period, and it is required to shorten "on" period Ton of the formula 2, or to make current inclination Vdc/L small for that purpose.

[0022]In order to say that switching frequency fsw of a current switching means is made high as a concrete means for shortening an "on" period and to make current inclination Vdc/L small, it is required to enlarge inductance L of a coil.

[0023]The output of the current detecting element which is a part of current detecting means at the time of a light load becomes very small as another cause by which power-factor-improvement operation becomes insufficient, compared with the time of heavy loading, and the technical problem said that operation of a controlling circuit part becomes less the optimal as a result occurs.

[0024]It aims at providing the power factor improvement circuit which makes it possible to solve an aforementioned problem, and not to be based on a load condition, but to keep a power-factor or more at 0.9 in this invention.

[0025]This invention aims at power loss reduction by a current sensing resistor, and aims at improvement in the efficiency of a power factor improvement circuit.

[0026]Although explained especially taking the case of the pressure-

up type power factor improvement circuit, this invention is applicable also in the power factor improvement circuit of the lowered type of the pressure, a step-down-and-step-up type, or other methods.

[0027]

[Means for Solving the Problem]In order to solve an aforementioned problem, this invention makes variable switching frequency of a current switching means of a power factor improvement circuit.

[0028]This invention makes a profit of a current error amplifier variable. This invention makes a current sensing resistor variable.

[0029]This invention makes an inductance value of a coil variable according to current which flows through a coil.

[0030]

[Embodiment of the Invention]In order to solve an aforementioned problem, this invention makes variable switching frequency of the current switching means of a power factor improvement circuit. By making switching frequency of a current switching means variable, with low loading, the power-factor near 1 is secured with high frequency, and mitigation is aimed at for switching loss using the switching frequency of 1 / 3 - 1/2 to the time of a light load at the time of heavy loading.

[0031]This invention makes the profit of a current error amplifier variable. At the time of a light load, the profit of a current error amplifier is set up greatly relatively.

[0032]By making a current sensing resistor variable, this invention makes a current sensing resistor small relatively at the time of heavy loading, and aims at power factor improvement in the time of reduction and a light load for the power loss in the resistance concerned.

[0033]This invention makes inductance of a coil variable according to load current.

[0034]

[Example]The example of this invention is described with reference to drawings below.

[0035](Example 1) It is an amplifier with which 7 of drawing 1 detects a current sensing resistor, and 8 detects the signal.

[0036]As for an output voltage detection means and 15, the actuator in which 9 drives the current switching means 1, the amplifier with which 11 amplifies the difference of the output of the amplifier 8 and the multiplier 12, and 13 are [an input voltage detection means and 16] signal generators. 20 is a comparator which compares the output and reference level of a current detecting element, and turns on and off the switch element 21 according to it.

[0037]17 and 18 are the resistance and electric capacity which determine the clock frequency of a signal generator.

[0038]By making the switch element 21 one, 19 is resistance for making resistance small equivalent, and can make clock frequency of the result signal generator smaller than the time of OFF of the switch element 21.

[0039]The potential difference of the both ends of the current sensing resistor 7 changes according to the load current which flows through it. The signal equivalent to this potential difference or it is

told to the amplifier 11 and the comparator 20 via the amplifier 8.
[0040]One [the comparator / the comparator 20 outputs a high and / the switch element 21] if the output signal and reference level of a current detecting element are compared and the output signal has exceeded reference level. As a result, the resistance 18 and 19 becomes parallel, combined resistance is formed and apparent resistance becomes small.
[0041]As a result, the clock frequency of a signal generator becomes low and the switching frequency of the current switching means 1 also becomes low synchronizing with it.
[0042]Conversely, the output signal of the amplifier 8 is less than reference level, or when equal, the comparator 20 maintains a low state, therefore the switch element 21 is off, and the clock frequency of a signal generator does not change.
[0043]Drawing 2 and drawing 3 express the variation of the method of the signal generator 16, resistance, and connection of electric capacity, and drawing 2 is a case where the resistance 19 is contained in series to 17.
[0044]Drawing 3 is a circuit to which the clock frequency of a signal generator is changed by change of electric capacity, and when the electric capacity 22 is contained in parallel to the electric capacity 18, as for drawing 3 (a), drawing 3 (b) shows the case where 22 is contained in series to 18.
[0045]In any case, when load current exceeds the preset value decided beforehand, the output of the comparator 20 becomes a high, the switch element 21 is made one, and it works in the direction which makes clock frequency of the signal generator 16 low.
[0046]If the clock frequency of a signal generator becomes low as already stated, it will become low, as a result, switching loss will be reduced, and the switching frequency of the current switching means 1 currently driven synchronizing with it will also lead to the improve efficiency of a power factor improvement circuit.
[0047]When load current is lower than a preset value, the output of the comparator 20 is a low, It is an OFF state, therefore the clock frequency of the signal generator 16 is maintained by the high preset value, the state of the control imperfection by current discontinuity of the switch element 21 is lost, and, as a result, a power-factor is maintained by 0.9 or more high levels.
[0048]Improvement in the power-factor at the time of a light load and improvement in the efficiency at the time of heavy loading are realized by the above operations.
[0049]Although the switch element 21 used the sign of the bipolar transistor on the drawing, it can also use JFET, MOSFET, a thyristor, a triac, a photocoupler, or a relay.
[0050](Example 2) The operation at the time of constituting the signal generator 16 from the frequency generator 23 and the counting-down circuit 24 is explained using drawing 4.
[0051]In signal generator 16', the frequency generator 23 is operating on frequency higher than the switching frequency of the current switching means of a power factor improvement circuit, and has generated the signal of predetermined clock frequency by carrying out dividing of the output wave of 23 by the frequency

divider 24.
[0052]25 is a signal converter which generates digital one or the analog signal according to the output of the amplifier 8, and a division ratio is set as two or more steps, and is settled by the frequency divider 24 according to the output of the signal converter 25.
[0053]The load current and the division ratio which flow through the current sensing resistor 7 have a relation of a monotone increase, as shown in the graph 5, but the function showing those relations can take linearity or a nonlinear form according to the contents of control.
[0054]If load current increases with this relation, a division ratio will become high, and a division ratio can be set up become low if load current decreases.
[0055]Therefore, when it will become low if load current increases, it has the characteristic which becomes high when load current decreases, and load current, as a result, also increases the switching frequency of the current switching means 1, it becomes low, and when the clock frequency of a signal generator decreases, it has the characteristic which becomes high.
[0056]Improvement in the power-factor at the time of a light load and improvement in the efficiency of heavy loading are realized like (Example 1) by such operation.
[0057](Example 3) By changing the amplification factor of the amplifier which amplifies the signal from a current sensing resistor using drawing 6 explains how to improve a power-factor.
[0058]25' of drawing 5 is an amplification factor determination means to determine the amplification factor of the amplifier which amplifies the signal from the current sensing resistor 7. The amplification factor determination means 25 determines the amplification factor of an amplifier according to the signal from the current sensing resistor 7.
[0059]Since load current is small at the time of a light load, the potential difference generated to the both ends of a current sensing resistor is small, the information for controlling runs short, operation of the controlling circuit part which carries out drive controlling of the current switching means becomes insufficient, and, as a result, power-factor-improvement operation becomes insufficient.
[0060]Therefore, by setting the amplification factor of an amplifier to the case at the time of a light load greatly, operation of a controlling circuit part becomes enough required, and it enables the effect of power factor improvement to obtain.
[0061]Since load current becomes large at the time of heavy loading and the potential difference generated to the both ends of a current sensing resistor becomes large, even if it makes an amplification factor small, operation of a controlling circuit part is not affected, therefore the effect of power factor improvement is acquired enough.
[0062]When a high current furthermore flows, and the amplification factor is being fixed, the output of an amplifier may be saturated and it may become out of control, but the loss of control by the output saturation of an amplifier can be prevented by setting up the

amplification factor according to load current as mentioned above.
[0063]It becomes possible for such an operation not to twist to a load condition, but to keep a power-factor or more at 0.9.
[0064](Example 4) By changing the resistance of a current sensing resistor using drawing 7 explains how to improve a power-factor.
[0065]7' of drawing 7 (a) is the 2nd current sensing resistor that leads to the current sensing resistor 7 in series, and 26 is a switch element which short-circuits current sensing resistor 7' by operation which it is connected to the both ends of current sensing resistor 7', and is described below.
[0066]The load current which flows in the current sensing resistors 7 and 7 at the time of a light load is comparatively small, therefore is comparatively small. [of the loss generated in the resistance group]
[0067]The potential difference generated to the both ends can be set as required enough levels, when the controlling circuit part operates by choosing the resistance of current sensing resistor 7' appropriately.
[0068]Since load current will increase if it becomes heavy loading, the potential difference generated to the both ends of the current sensing resistors 7 and 7 also increases.
[0069]When the output of the amplifier 8 which amplifies the signal from a current sensing resistor is set up connect too hastily when the level set up beforehand is finished and the switch element 26 short-circuits, the switch element 26, It becomes impossible for load current to flow through current sensing resistor 7', and, as a result, it can set the loss by the resistance to 0.
[0070]Although conventional current detection resistance sets up about 0.01-0.05ohm, considering the case where the load current of 1A is temporarily sent using 0.02 ohm of resistance, the potential difference generated to the both ends is set to 20 mV, and, specifically, operation of a controlling circuit part becomes insufficient very small as a control signal.
[0071]When 10A is passed to the same resistance, potential difference is 200 mV, but a loss occurs 2W.
[0072]When load current is 1A on the above conditions, it can realize a 200-mV signal and low-loss [of 0.5W] in one circuit by performing variable [of resistance which it says is 0.05 ohm at the time of 0.02ohm and 10A].
[0073]Improvement in the power-factor at the time of a light load and improvement in the efficiency of heavy loading are realized by such operation.
[0074]About the method of connection of the 2nd current sensing resistor, the same effect can be acquired by there being also the method of connecting in parallel to the current sensing resistor 7 like drawing 7 (b) in addition to the above, and setting up so that the switch element 26 may short-circuit similarly also in this case at the time of heavy loading.
[0075](Example 5) The effect of the power factor improvement at the time of the light load by variable [of inductance] is explained using the graph 8 and drawing 9.
[0076]The graph 8 expresses the current characteristic of the inductance which a coil has. Drawing 8 is a block diagram of a

general pressure-up type power factor improvement circuit.
[0077]usually, to change of load current, although it is about 1 law, a predetermined power-factor (0.98 or more [for example,]) is securable [in such the characteristic / at the time of 100% of load] with a coil with the general characteristic, to the rating of a power factor improvement circuit.
[0078]However, it is for the section when load power becomes small at, current becomes discontinuous at, for example at the time of 50% or less of light load of rating at the time of a light load, and control is impossible to occur.
[0079]Detailed explanation is as [Problem(s) to be Solved by the Invention] having described. In order to lose or lessen the section of current discontinuity also in the time of a light load, it is one of the solution to change the inductance L of a coil according to load.
[0080]That is, it is realizable by using the coil that the inductance L becomes small greatly at the time of heavy loading at the time of a light load.
[0081]Especially in the core material of the coil put in practical use now, since what is called a dust core has the characteristic near it, an above-mentioned remedy can be embodied by realizing the characteristic of the graph 8 by the improvement of material.
[0082]
[Effect of the Invention]According to the invention according to claim 1, by changing the switching frequency of a current switching element according to the output of a power factor improvement circuit so that clearly from the above-mentioned example, That is, when exceeding 2fc and 50% to rating at the time of 50% or less of load, by performing control, such as fc, generating of the current discontinuity in the time of low loading can be suppressed, and power factor improvement can be realized, and improve efficiency by the switching loss reduction in the time of heavy loading can be planned.
[0083]The setting out of a load level can carry out optional setting among 10 to 90% not only with 50% but with actual frequency in use etc., and two steps or setting out beyond it is possible also for setting out of the switching frequency of a current switching element.
[0084]According to the invention according to claim 4, the amplification factor of the signal of a current sensing resistor, It can enlarge at the time of low loading with small amplitude of a signal, the amplitude of the signal sent to the controlling circuit part of a power factor improvement circuit by setting up small at the time of heavy loading can become a proper size, as a result, the accuracy of operation of a controlling circuit part can improve, and the effect of power factor improvement can be maintained beyond constant value.
[0085]By setting up the resistance of a current sensing resistor greatly at the time of low loading according to the invention according to claim 5, The amplitude of the signal sent to the controlling circuit part of a power factor improvement circuit becomes proper, and, as a result, the accuracy of operation of a controlling circuit part improves, By being able to maintain the effect of power factor improvement also in the time of low loading

beyond constant value, and setting up resistance small at the time of heavy loading, the loss by a current sensing resistor can be reduced and improve efficiency of a power factor improvement circuit can be planned.

[0086]By making inductance of a coil variable according to load current according to the invention according to claim 6, That is, inductance is enlarged at the time of the small low loading of load current, by making inductance small at the time of the large large load of load current, current discontinuity can be controlled and, as a result, the effect of power factor improvement can be maintained also in the time of low loading.

[Translation done.]